

Drinking Water Energy (Cost) Savings Handbook



November 2014

Cover photo: Jordan Valley Water Conservancy District's Webster Well

Courtesy of Kim Dyches, Division of Drinking Water

Drinking Water Energy (Cost) Savings Handbook

Table of Contents

Acknowledgements.....	i
1. Introduction	1
A. Energy Savings Potential	1
B. How to Use This Document	1
C. Finding the Right Consultant	2
D. Drinking Water Board’s State Revolving Fund:	4
2. Energy Saving Investigation Process	5
I. Conservation Related Efficiencies.	7
II. System Modeling Efficiencies.....	11
III. Water Source (or Supply Side) Efficiencies.....	14
IV. Water User (or Demand Side) Efficiencies	15
V. Pumping System Efficiencies.....	16
VI. Storage System Efficiencies	18
VII. Distribution System Efficiencies.....	19
VIII. Plant or Treatment Facility Efficiencies.....	20
IX. Technology and SCADA Efficiencies.....	20
X. Internal or Operational and Behavioral Efficiencies.....	22
XI. Energy Supply, Timing, Control, and Backup Efficiencies	24
XII. Energy and Power Rate Dynamics	28
XIII. Engineering and Design Efficiency Goals.....	30
3. Funding Opportunities.....	34
A. Drinking Water Board.....	34
B. Utah Office of Energy Development.....	35
C. Energy Service Companies:	36
D. Rocky Mountain Power’s Wattsmart Program	37
E. Self-funding through Energy Savings	37
F. Bank Financing	38

Appendix.....	42
A. Case Histories of Water Systems taking advantage of energy cost savings	42
B. Drinking Water Board’s financing program.....	42
C. Utah Office of Energy Development’s U-Save Program	42
D. Energy Service Companies	42
E. Rocky Mountain Power’s wattsmart program.....	42
F. Web sites that give guidance on performing Energy Audits	43
G. Additional helpful web sites.....	43

Acknowledgements

This document was prepared by many people and it is appropriate that they be given credit for their work. I will proceed in giving credit consistent with the order in which this document is presented. I acknowledge the work done by **Steven Jones** with Hansen Allen & Luce, consulting engineers for pioneering the use of extended time running of hydraulic models to identify pump and piping changes that would enable energy savings. I thank **Frances Bernards**, Environmental Scientist with the Department of Environmental Quality's Business Assistance Program, for her work in researching and preparing case histories of the energy and cost savings for the three systems highlighted in Chapter 1. **Ryan Taylor**, with Epic Engineering provided information on the approach to selecting a consulting engineer.

The funding incentives provided by the **Drinking Water Board** is a matter, as set forth in State Statute (19-4 UCA) that must be formally acted upon by the Board. At the Board's August 27, 2014 meeting **Michael Grange**, Construction Assistance Section Manager within the Division, provided well-reasoned options for the Board to consider. The options were further addressed in a work meeting of the Board held prior to their November 7, 2014 meeting. Board members: **Paul Hansen**, Board Chair, **Betty Naylor**, Board Vice Chair, and members: **Brett Chynoweth**, **Tage Flint**, **Roger Fridal**, **Brad Johnson**, **David Sakrison**, **David Stevens**, and **Mark Stevens** provided valued direction to the Division.

Next I recognize **Doug Evans**, who prepared the entire contents of Chapter 2. The content of this chapter contains an extensive list of ideas that water systems can utilize to save money on their energy bills. **Doug Evans** has tried, with success, many of the ideas listed in the chapter for the benefit of the utility, Mountain Regional Water Special Service District (Summit County), he works for. It is important to note that the Water District's energy savings reported in Chapter 1 does not state that **Doug Evans'** work is complete. He has plans in the near term that he will pursue, which will increase the annual savings for his water system.

Chapter 3 of this document lists the funding opportunities provided by various entities. As should be suspected, the individual sections were authored by representatives of these entities. Therefore I thank **Michael Grange**, who wrote the section dealing with the Drinking Water Board's funding program; **Jennifer Gardner**, of the Utah Office of Energy Development, who wrote the section dealing with her office's program; **Mark Cram**, with Siemens, an energy service company that is Certified by the State, who wrote the section dealing with Energy Service Companies; **Martie Leo**, and the Rocky Mountain Power External Communications Group, who wrote the section dealing with Rocky Mountain Power's Wattsmart Program; and **Johnathan Ward**, Vice President with Zions Bank, who wrote the section dealing with bank financing.

Kenneth H. Bousfield, P.E., Director
Utah Division of Drinking Water

1. Introduction

This document was prepared to provide water system operators and managers with ideas on how to save a significant amount of money by reducing the cost of power necessary to provide water to their customers. As a minimum, the ideas presented herein should enable water systems to lower the cost for power in spite of rate increases implemented by power companies in the coming years.

A. Energy Savings Potential: A number of drinking water systems throughout the State have realized significant dollar savings by implementing strategies that promote energy efficiencies. As an example, Mountain Regional Water Special Service District (Summit County) <http://www.deq.utah.gov/Topics/FactSheets/docs/handouts/2014/09Sep/MountainRegCS.pdf> saved over \$300,000.00 per year on projects throughout their system, Logan City (Cache County) <http://www.deq.utah.gov/Topics/FactSheets/docs/handouts/2014/09Sep/LoganCityCS.pdf> saved nearly \$119,800 per year by adding a new pressure zone, and Riverton City (Salt Lake County) <http://www.deq.utah.gov/Topics/FactSheets/docs/handouts/2014/09Sep/RivertonCS.pdf> saved over \$42,000 per year on modifications to a single pump station. Each of these water systems were able to realize these savings by implementing one or more of the strategies listed in Chapter 2 of this handbook.

Equally interesting is the number of financing approaches available to water systems that take advantage of them. These include: a) low cost loans offered by the State's Drinking Water Board (administered by the Division of Drinking Water) as well as the State's Energy Office, b) low cost, short term loans offered by the State's Office of Energy Development, c) design, build projects by State Pre-Qualified Energy Service Companies, d) cost reimbursement programs offered by Rocky Mountain Power, e) short term internal loans between two separate agencies within a city's or town's government, and of course f) bank financing.

B. How to Use This Document: This document is designed to give suggestions on: a) what to look for to save energy costs, b) where to look for funding needed to pay for changes in infrastructure, and c) where to look for helpful information available via the web.

The second chapter lists more than 300 ideas that may be available for water systems to take advantage of. Each section of this chapter has helpful icons in the left margin that will signify: 1) changes that water system operators and managers may implement, 2) changes that an appropriately qualified technical advisor may assist in identifying and 3) designed and constructed facilities. All of these changes and facilities, if instituted or constructed, will result in cost savings.

The third chapter lists six different funding sources for implementing ideas that save money. A description of these funding sources and the requirements needed to qualify are also provided.

The Appendix lists helpful websites and gives a brief description of what the site offers as well as the web's URL address.

The first step in the process is to perform an **Energy Audit**. While this document does not give guidance on this process, five websites listed in Appendix F link to instructions on performing them. It is recommended that water system personnel and consultants perform an energy audit to obtain a baseline of information. Energy audits are required by some of the funding entities. Also energy audits identify specific unit power costs which may identify obvious opportunities to save money by turning on high energy consuming facilities last and then turning them off first.

Significant additional help is provided in Chapter 2, which lists a wide range of ideas that could lead to energy savings. This chapter has helpful icons in the left margin that classify the ideas into specific categories: 1) Things water system personnel can do, 2) Things a consultant can assist water system personnel to do and 3) Things that require equipment replacement and/or construction. It should be noted that the line between: things water system personnel can do and thing consultants could assist water system personnel do, will vary depending upon the expertise of the water system personnel. The line between these two arrangements is drawn for the small water systems operator (a volunteer) in this document.

C. Finding the Right Consultant: The serious water system should consider pursuing all applicable suggestions listed in Chapter 2. When a water system proposes construction and/or equipment changes, the State requires that plans be submitted to the Division of Drinking Water. Such plans must be prepared by a licensed engineer. Ideally the selected engineer will be qualified to make meaningful recommendations regarding energy efficiency. To help ensure that the “expert” will provide the desired help, it is recommended that the water system go through a “Request for Proposal” (RFP) process. In essence, the RFP process involves sending out an invitation to multiple consultants to respond. In the response, the consultant provides information which the water system uses to select the best candidate consultant.

The RFP should list the objectives of a proposed project, such as: “a desire to significantly reduce power costs for the utility”. To enable applicants to provide meaningful and helpful information, the RFP should include, possibly in a table format, the following information about the water system, including: number of pumps, age of each pump, horse power and flow rate of each pump, service area elevation range, number of pressure zones, and location, elevation and volume of each storage tank. The RFP should include a request for at least the following information:

1. List the drinking water systems the consultant has worked with and identify the energy cost savings each system realized. Provide contact information for the systems that the consultant worked with.

2. Provide the names of staff, including sub-contracted staff, which will be assigned to do the work for the water system. Include the water systems that each identified staff has done comparable work for. Also provide resumes of identified staff, including: education, training and applicable experience.
3. Provide a statement of the specific areas of opportunity for energy cost savings that the consultant feels can be implemented for the water system.
4. Provide a statement of the consultant's qualification to investigate each of the thirteen sections in Chapter 2 of this document (a copy of this document should accompany the RFP). This should include any appropriate certification(s) that individuals or organizations who will work on the project will have, such as: 1) A Rocky Mountain Power Certified Energy Auditor, 2) the Utah Office of Energy Development Certified Engineer and/or 3) State Certified Energy Service Company.

Note that the question "how much will you charge" is not asked. This is because the intended project is to maximize the energy cost savings of the utility. As such, the utility will want a more detailed investigation performed by a highly qualified individual, rather than a limited investigation produced by a less qualified expert.

From the RFP a water system may select the most qualified consultant and proceed with negotiating a contract. If two or three applicants appear to be equally qualified, an oral presentation by each applicant on the short list may be warranted. Applicants on the short list should be invited to give more detail on their proposal in a schedule interview. The invitation should list the specific questions that will be asked during the interview. The following questions are examples of what might be included in the invitation and interviews. Use only applicable questions.

1. Please outline the process of investigation you'll use in identifying the energy saving opportunities available to our water system. Will this process include non-construction actions our water utility personnel can pursue? Please give examples of the non-construction actions.
2. Please identify the most beneficial energy saving opportunities you'd recommend for our water system, and an estimated range of savings.
3. Because of budget concern, we would like to proceed with a capital facilities plan that will enable us to finance future projects with cost savings from earlier projects. Is this possible? Would you be able to prepare such a plan and work with us on achieving it?
4. What funding opportunities do you see are available for us?

5. Is there anything you would wish to share with us that would distinguish you from the other applicants we interview?

The object of the interviews is to select the applicant that you'll negotiate a contract with. Hence the questions selected should be pertinent to your situation and sufficient to stratify the qualifications of the remaining applicants.

After selection of the consultant and during the design phase, the consultant should also identify funding sources in cooperation with the water system. Chapter 3 of this document gives insights on 6 different possible sources of funding. Some funding may involve all or partial grant funding or cost recovery. Other sources of funding involve loans, with varying loan interest rates and loan time periods.

The appendix includes links to websites that provide helpful information. For example, Appendix B, C, D, and E access information about the various funding sources listed in the document. Appendix F lists website that provide guidance in performing energy audits.

D. Drinking Water Board's State Revolving Fund: By State Statute, the Drinking Water Board has the authority to administer State funded drinking water projects. There are two sources of funds, federal and State, which the Board oversees. The Division of Drinking Water acts as staff to the Board in implementing the funding process. The Board offers the following incentives to applicants seeking financial assistance from the Board:

The Board and staff are working on developing rules that will provide incentives for utilities to pursue energy efficient projects. The first incentive will involve the preparation of master plans that include: a) the over-all perspective of issues associated with master plans and b) an energy audit that identifies actions a water utility can take to increase efficiency as well as projects that will increase energy efficiency. The Board's incentive will involve financially attractive assistance to include the energy piece in the master plan. The second incentive that the Board will consider is a reduction in the interest rate for projects that include energy efficient components.

2. Energy Saving Investigation Process

While the list below appears extensive, it is still not inclusive of everything, as such, do not become overwhelmed. The rewards of this exercise will likely be small in some areas, but can be great in others. Remember that summed together, they can show significant economies in operational performance and costs. Go about this effort in a spirit of learning, then teach or mentor others.

At the end of this chapter is a list of the definitions for all acronyms used within this chapter.

HAVEFUN!

RESOURCE NEEDS AND EFFORT:



The following energy conservation inventory is divided into sections or groups of processes which possess similar efficiency characteristics. Each inventory item is further classified within the left page resource sidebar, with a road sign indicating the potential degree of difficulty or involvement needed to assess and remedy. The items are classified into three (3) energy auditing tiers alongside a corresponding project, or group of projects, indicating the possible resources needed to accomplish the tasks. The Tier indicator applies to all projects adjacent and below it, up to the next indicator presented. Be advised that the tier level may change depending on the proficiency of the water system. Some systems may be able to accomplish more tasks internally, and others may need more assistance than indicated. Each Auditing Tier is detailed below:



1. **TIER 1.** The square green sign signifies that the local water system personnel can most likely accomplish the evaluation or task. If not – the system should look to the Rural Water Association for training and/or assistance (see Tier 2 below).



2. **TIER 2.** The square brown sign signifies that a professional organization such as the Rural Water Association of Utah (RWAU) can assist water system personnel with this extended effort. If they feel they cannot assist – they will recommend that the utility proceed to the next tier (see Tier 3 below).



3. **TIER 3.** The square blue sign signifies that the level of involvement will most likely involve a paid consulting engineer or other similar professional who can more readily assist with the audit and evaluation. These evaluations typically involve much more complex levels of study, and are also likely need financial assistance to complete. (See chapter 3 for more information about funding.)

The signs below are added in addition to the 3 above if a special effort is indicated:



- A. The orange road construction a head sign is attached along with one of the above signs, and signifies that the project will likely require some equipment replacement and/or newly constructed facilities.



- B. The addition of the yellow high water sign signifies that this project may be much more complex or more difficult than others, and may require more study and other resources. The rewards may be greater though.



- C. The dollar sign insertion indicates the project could be more costly than others – but, with the cost high, the savings may also be high.

- The Energy Saving Investigation Process -

I. Conservation Related Efficiencies. Energy conservation almost always begins with water conservation, including the process of improved accounting for water losses within the various complex operational systems.

A. Water Conservation. Encouraging water conservation has a direct linkage with energy conservation. Not only does it save energy resources, it also frees up water that can be used for future uses, reducing the dependence on higher prices involved with source development, including: capital costs, water rights costs, or operational costs. Any conservation planning effort should at least look at the following basic strategies and include implementation plans as practical:

1. **The Plan** – Develop a comprehensive Water Conservation Plan and review the relationships between water and energy conservations therein.
2. **Implementation** – Implement ordinances and rules and regulations which affect the strategies and goals contained within the Conservation Plan.
3. **Measure Accurately** - All water use, including separate meters for irrigation and domestic uses, if necessary.
4. **The Standards** – Know what the real supply and demands of your water system are. Know what a typical Equivalent Residential Connection (ERC) uses in a year, an average month, and a peak month and day if possible. Use these standards to compare conservation performance overtime.
5. **Price water to recognize its finite nature** - Pricing mechanisms should provide incentives to water users who conserve water as well as penalties for those who waste it.
6. **Hold Responsible** - all water users for protecting the quality of water resources at their disposal.
7. **Incentives** - Create financial or publicity incentives to reward users for efficient irrigation systems. Key elements to observe are system design, operation, and maintenance, combined with effective scheduling and management practices.
8. **Education** - Create or assist in educational programs, which emphasize to all water users the absolute necessity of supporting regulatory policies, which reward conservative and efficient water use.
9. **Reclaim** - Support water reclamation initiatives if feasible, particularly for irrigation, including the use of reclaimed water from municipal, industrial, and other available sources, where practical.
10. **Prioritize Water Development** - Give increased support to developing new water resources, conveyance, and storage facilities, which enhance dependable water supplies for urban and agricultural use, with proper consideration given to legitimate environmental concerns.
11. **Buy-In** - Participate in water conservation planning as an ongoing program. These plans must be in place prior to a critical need and must provide for each water user's acceptance of a fair share of any water conservation effort.
12. **Manage the Resource** - Institute studies to identify water use and misuse by all segments of the water using industry to provide data on which to base





decisions regarding equitable water distribution during periods of drought or other shortage or water quality event.

13. **Manage the Peak** - Investigate innovative water storage projects, to allow the supplier to better manage its water resources during peak periods of the year.
14. **The Water and Energy Nexus** - Meld Water and Energy Conservation into a unified strategy. Water and Energy share many of the same conservation strategies and should be looked at conjunctively in any conservation program.
15. **Water Loss Reduction Programs** - Are very necessary to demonstrate to customers that the water supplier is doing everything possible to minimize water loss on the supply side of the equation while promoting conservation programs to the end users on the demand side.
16. **Legislative Actions** – City or County Landscape Ordinances can save considerable resources when properly applied in the initial project planning and design phases.

B. Water Accountability. Accounted and unaccounted water losses waste significant energy, resources, and money, and can be at least partially remedied through a regular water audit and thorough investigation using the processes below. Most types of water losses fit into one or more of the following categories. Each system should develop a program to regularly or even continually (using SCADA) investigate, quantify if possible, and mitigate as much water loss as possible. (NOTE: leak detection instruments may be required in many of the tests needed for this program). The categories of water loss are:

1. **Unbilled Metered Consumption:**
 - a. This is usually a water revenue loss (if the meter is read) resulting usually from a defect in the accounting and billing systems and controls of the utility (also see 5 below).
 - b. This can also be a loss from special agreements, judgments, or other special treatment of customers who are metered (at least making a demand reading usable in a water audit - if read).
 - c. This can also be a water and revenue loss if the meter is NOT read.
 - d. The water utility owned facilities can often fall into this category, i.e. offices, plants, etc.
2. **Unbilled Unmetered Consumption:**
 - a. This category consists mainly of forgotten customers, or
 - b. Often users that are some of the earliest connections which might be forgotten or were believed to be terminated in the billing system but not disconnected.
 - c. Firefighting and other emergency water uses fall into this category.
 - d. Again – often the water utilities own facilities can fall into this category.
3. **Unauthorized Consumption:**
 - a. This typically involves: water theft, illegal users, or



- b. connections that have been unauthorized in the past and not disconnected.
- c. Unauthorized construction water users will often be found here (i.e. a meter by-pass) if not regularly checked up on.

4. Customer Metering Inaccuracies. These errors result usually from:

- a. Lack of a meter testing and replacement program.
- b. Meters that are not designed for the particular application or installation configuration.
- c. Meter that are too old, obsolete, or are reaching their end of life.
- d. Meters that are damaged or partially or completely plugged.
- e. Meters that have failed.
- f. Meters that have lost their power source (if applicable) or their electronic read system batteries have been depleted.
- g. Meters damaged or stopped due to freezing conditions.
- h. Meters that cannot be tested or verified due to their inaccessible conditions, i.e. in the basement or crawlspace of a home, etc.
- i. Lost meters.
- j. Vandalized meters or reading equipment.
- k. Oversized meters, particularly on services where the meter was designed to handle fire flow demands from a fire sprinkling system.

5. Systematic Data Handling Errors. This category is where errors in data processing occur, namely:

- a. Clerical data entry errors.
- b. Meter data configuration errors, i.e. types, size, units billed, zero multiplier units, etc.
- c. Meters coded to the wrong customers.
- d. Billing system rate entry and testing errors.
- e. Errors or “bugs” in the actual firmware of the reading equipment or the software used for reading equipment and billing.
- f. Errors due to the lack of maintained software updates.
- g. Lack of an accounting control system to review or check up on billing reports, meter work orders, etc.

6. Leakage on Distribution System Mains:

- a. Leak detection audits should be performed on a regular schedule, starting with older and less reliable infrastructure.
- b. The establishment of a system typical water loss baseline, aids in the identification of new leaks as well as performance of you water loss programs.
- c. Meter performance and testing. A regular testing program should be implemented. Many residential meters have an accuracy curve that drops significantly after 10 to 15 years. As much as a cup per minute or more can pass undetected through some meters. Larger systems should consider purchasing or constructing their own meter testing benches.
- d. Master metering should be provided where practical, when a large user base is fed off of one or two line(s), and mass balance tests



- e. reviewed regularly (supply in, less the summed user meter demands).
- e. Fire hydrant leak tests should be performed regularly.
- f. Operational leaks, i.e. flushing and testing should be metered and accounted for if possible.
- g. Fire department tests – if unmetered, an estimate should be maintained by the fire department and submitted to the utility.
- h. Sewer system flushing programs should utilize hydrant meters.
- i. Construction water should be metered. Investigate the installation of metered bulk water stations if construction water places a regular heavy demand on a system. This can reduce significantly wear and losses on fire hydrants.
- j. Fire hydrant meters should be tested regularly. They fail or can be damaged fairly easily, especially if used for construction water.
- k. Can the SCADA system be provisioned to monitor for water losses on a real time basis?
- l. Investigate the implementation of automatic PRV pilot adjustment systems which can adjust pressures for high and low demand periods. Lower pressures at low demand periods can reduce water losses on the distribution system.
- m. Regularly check for water losses at PRV stations and other distribution system regulation valves.
- n. Air-vac and air release valve stations are an often overlooked source of water losses. Many of these are lost and hidden, but can result in significant losses if damaged from freezing or other problems.

7. Leakage on Service Lines (laterals):

- a. If a leak is found on a service line after the meter, due to corrosion or age – there is a very good chance there is a leak on the service line feeding the meter.
- b. Know where all service line valves are using maps, GPS, GIS, etc. Most of the time these are covered over by the customer.
- c. If a customer has a fire sprinkling system, does it have a tested flow detection system?
- d. Know the soil conditions in areas that are prone to leaks.
- e. Use service line materials and depths which are more suitable to your environment and soil conditions.
- f. Automated Meter Read systems can aid in the locations of service line leaks by observing trends throughout the night or unoccupied seasons or times. They can also detect leaks from freezes etc.

8. Leakage on Tanks and Overflows:

- a. Leaks in tanks can be found through regular internal and external inspections.
- b. On metal tanks – inspect for corrosion and cathodic protection issues. Recoat the tank if necessary.



- c. Check for leaks in tank control vaults and valve systems, including tank level regulating altitude valves.
- d. Excessive water overflow and other losses in tanks can be caused or remedied by the following:
 - i. Proper Placement of Reservoirs and PRV's. Keep pressures feeding an altitude valve at a minimum if possible.
 - ii. If feasible - use PRV's less and reservoirs more for pressure control.
 - iii. Investigate the use of reservoir inlet and outlet detection devices.
 - iv. Investigate reservoir emergency or seismic control valves which close to protect storage in an emergency water loss situation.
 - v. Investigate reservoir overflow detection systems.
 - vi. Watch for reservoir level transducer failures or improper level calibrations.
 - vii. Ensure that reservoirs are properly vented and protected.

9. Leakage within Plants and Equipment:

- a. Check for leaking pump surge anticipator or pressure relief valves which discharge water to the atmosphere.
- b. Check for leaking pump control valves (deep well type) which may discharge water to atmosphere.
- c. Check pumps for excessive leaks in pump seals.
- d. Check for leaking air-vac and air release valves in pump stations and treatment plants.
- e. Regularly check for water losses at regulation valves including altitude valves, electric and pneumatic actuated valves, pump to waste PCV's, and PRV's.
- f. Ensure that filter to waste cycle times are not overly excessive.
- g. Investigate the feasibility of backwash water re-use, either internally or for irrigation etc.
- h. Inspect sedimentation, mixing, clarifier, filter basins, systems and the like regularly for leaks, performance issues, etc.
- i. Monitor for leaking well foot or other check valves on sources.

II. System Modeling Efficiencies. One of the first steps necessary to the proper development a comprehensive energy audit of a system is to perform an extended period computer model to evaluate the source, distribution, and pumping system(s) functions and performance. While the modeling can be somewhat complex, system personnel and others can assist with the data gathering and mitigation or repairs necessitated thereby. Modeling – particularly “Extended Period” modeling is also a dynamic process which needs to be regularly reviewed and “fine-tuned” as needs arise, new data becomes available, and system conditions change. As a part of this evaluation, the following energy demanding scenarios (among others, such as water quality conditions) should be studied. We begin with the “4-L’s”, or the primary efficiency modeling “red-flags”:



- A. Looping.** The process of unwarranted or repeated boosting of the same water. Ask this question: Could a pump or systems of pumps be boosting water, or any portion thereof in one or more continuous loops? Such loops can be found, among other possibilities, in the following places:
1. In the distribution system piping through inter-zonal connections, where a booster station pumps water from a lower zone to a higher zone, and water can be routed back down (around the booster and back to the suction side) through one or more locations or devices, such as:
 - a. PRV stations – where one or more station(s) are designed to be normally closed (open only in very high flow or fire flow situations), but failures occur through:
 - i. Improperly maintained PRV's, Failed Solenoid Controls, or Relief Valves and related PRV pilot control systems.
 - ii. Leaks in a PRV valve diaphragm or across the valve seat.
 - iii. Leaks in a standby or larger backup fire-flow PRV.
 - iv. Leaks in a by-pass gate or butterfly valve.
 - b. Leaking through normally closed zone isolation valves. Often these are also accidentally opened when their purpose is not understood. A normally closed valve should be marked as such in a valve box with an inserted pole, 2x4 board, flag, etc.
 - c. An improperly designed or applied PRV station (due to future distribution modifications), which should be kept closed or could be simply eliminated.
 2. In pumping stations where failures may occur through:
 - a. Leaking pump check valves, when one or more pump(s) are off.
 - b. Leaking surge anticipator or pressure relief valves, which discharge to the pump suction zone.
 - c. Leaking pump by-pass PRV or solenoid valve systems used to deliver fire return flows from the higher pressure pumped zone to the pump suction zone.
 - d. Water cooled chiller or air-handling systems used to cool a pumping plant, where a solenoid or control valve feeding the coils leaks from the higher pumped zone back to the suction side.
 3. Source and Treatment Facilities through:
 - a. Chemical (i.e. chlorine gas) feed systems or ejection systems, i.e. leaking pump check valves, solenoid valves, etc.
 - b. Leaks from corroded or damaged source well pump lines or well columns, where the water flows or circulates back into well casing annular space. This can also involve screen and corrosion issues.
- B. Leaping.** The process of unnecessarily pumping a source, such as a well around (or “leaping” over) a higher PRV separated pressure zone (often through a separate pumping line) to a tank, when the pump would be using significantly less energy by simply pumping the necessary demand pressures (or a portion thereof) directly into the pressure zone in which it is located. The remediation can usually be fully utilized if there are other sources or pumps that can supply the actual higher tank zone. The PRV's are now only used for high flows, emergency backup, or when the well or pumps cannot meet the necessary supply. Leaping can be mitigated by:



1. Well or booster pump station(s) pumped exclusively into hosted pressure zone, with flow controlled by zone pressure, i.e. VFD's or multiple pumps.
2. Well or booster pump station(s) pumped into upper tank zone pipeline only when needed by an automatic diverting valve, but used in lower zone as much as possible.
3. A combination of 1 and 2 above, achieved by adding a separate or smaller pump(s) (or dividing up pumps) to keep the hosted zone in water, with the others used to supply the upper zones.
4. Performance can be monitored by metering the pumps AND the inter-zone PRV's.

C. Losing Head. The process of unnecessarily dropping or breaking a usable water supply pressure, which could have been utilized in a local or adjoining zone without the drop. These conditions may be found in the following situations:

1. Breaking a spring HGL pressure pre-maturely or re-pumping a spring unnecessarily.
2. Underutilization of a flowing well, even if it is seasonal in nature.
3. Breaking a high pressure zone in a pumped system – just to be pumped up again to that zone or another higher pressure zone.
4. Remediation of this problem often involves re-provisioning or installing new pipelines to bring the pumping systems into a more efficient condition.

D. Loading. The processes involved in the efficient timing and efficient capacity loads and control of pumping systems. If done properly – significant savings can be realized, but if pump operations are random or uncontrolled or not optimized, the costs can be excessive. This problem is remediated as described in sections further down in this document, but is mentioned here because it is often discovered in the computer modeling processes. It is seen in a pumping and energy model by the following:

1. Well and booster pumps which pump a very high flow of water to a tank or user demand zone for short periods of time, i.e. less than 20 percent of the day.
2. Pumping systems engineered for some distant build-out capacity, but the current operational needs are only a fraction of the limit.
3. Pumping cycles which create an excessive head loss on the system.
4. Pumping systems which do not perform in their most efficient pump curve zones, or have an inadequate or poor suction head.
5. Well drawdowns which have changed significantly since the initial pump sizing.
6. Tanks and reservoirs which are sized too small to allow for a custom timed pumping cycle.
7. Pumping systems which model well if run in “off-peak” scenarios, but are not run as such.
8. Pumping systems utilizing an ineffective or efficient electrical rate tariff.
9. Pumping systems which are artificially restricted to control flows, such as valving, etc.
10. Pumps not prioritized and operated by efficiency constraints.
11. Worn or improperly maintained pumps.



III. Water Source (or Supply Side) Efficiencies:

- A. To begin with – ask yourself: “Is the source water actually making it to a tank? Does it really need to?”(See “Leaping” above). This can be modeled and monitored in a SCADA system setting.
- B. Run sources (or prioritize them) based on energy costs per unit of water (also known as Specific Energy), and choose the most efficient sources first – given water rights and other water quality implications and considerations. This figure would be in a unit such as kwh / Acre-foot, or kwh /MG, or kwh / 1000 gallons, etc.
- C. Monitor well Specific Capacity (standard flow per standard drawdown unit, such as gpm / foot) on a real time basis using SCADA to test for changing well efficiencies overtime or by season.
- D. Through a change application process with the State Engineer, determine whether water rights could be transferred from an expensive source to a less expensive one. Or could multiple sources or points of diversion share the same water rights, allowing you to have greater flexibility in how you operate sources.
- E. Monitor in real time with SCADA, and log sources and pumping systems for not only Specific Energy, as discussed above, but also Specific Power. This process allows you to see the effect of the demand component of your power bills and take steps to minimize its impact (i.e. should I use off peak, or load factor extension strategies). This calculation is typically expressed as kw / gpm or gpm / kw. This figure, along with Specific Energy, as described above, is also often used to check for the trending of pump efficiencies overtime, and possible needs for well and pump maintenance.
- F. Remain current on all water source protection plans and work to mitigate any possible threats to said source(s). Ensure that each source has an approved and recorded protection zone. Work with City or County officials to assist in the adoption of a source protection element to a zoning code or regulation. Losing a source, either temporarily or permanently can cost the public and the environment significantly.
- G. Monitor total source production monthly and daily if possible. Tie source capacity to the number of standardized ERC’s to establish a running trend of capacity utilized and available, as well as overall efficiency.
- H. Well Issues:
 1. Well screen maintenance issues creating a greater draw-down than the well was originally equipped for.
 2. Excessive VFD Harmonics or inadequate filtering, along with issues associated with excessive cable lengths between the VFD and motor.
 3. Improper well power cabling used for a VFD controlled motor.
 4. Well pump and/or motor sizing errors or condition changes overtime.
 5. Line drive well pumping systems are typically more efficient than submersible pump systems, if the well can be equipped for such and has the proper characteristics.
 6. Undersized well casing, preventing more efficient pump and motor selections.
 7. Corroded or leaking pump column piping.
- I. Spring Issues:
 1. Loss of flows due to roots or damaged collection systems.
 2. Lack of vegetation control in the spring collection areas.





IV. Water User (or Demand Side) Efficiencies:

- A. Implement increasing block water rates (with many tiers), including possible surcharges to higher demand customers. Doing this is the first step to actively encourage customers to be more involved in water conservation measures.
- B. Investigate zero based rates which provide no water in the base charge.
- C. Review the feasibility of high elevation rates or the establishment of high elevation surcharges to assess customers who place a higher pumping demand with related higher energy cost on the system.
- D. Review and update the water conservation plans and strategies as necessary (See conservation section above).
- E. Review system Rules and Regulations – to ensure that they promote conservation and penalize users for unnecessary water use and waste.
- F. Demonstrate resource conservation strategies and water education by participating in or developing annual school water fairs.
- G. Provide public education and assistance when possible to help conserve water or find known water losses.
- H. Reduce system leaks and water losses by implementing fixed based meter read systems, which read meters daily and hourly. Tie customer water meter reading system to work in conjunction with a carefully implemented master meter system(s). Generate daily reports, pinpointing areas where a water leak or break may be occurring. Use this system to assist customers in troubleshooting leaks on their side of the meters. Provide customers with daily water use statistics on company web pages to promote usage understanding and conservation.
- I. Regularly test and calibrate meters and perform regular upgrades as necessary.
- J. Follow AWWA Water Audit standards or your own, and perform annual water audits.
- K. Consider secondary water system metering, if you provide such, to save higher quality and treated water sources, and helping to avoid the often used term of, “you better use it or lose it”.
- L. Consider culinary irrigation metering systems or the metering of pools or large water features, separate from customer meters with large high use customers.
- M. Consider ET Irrigation Control Systems, or providing ET data to customers to assist in the programming of their irrigation systems.
- N. Provide customer – On-Site conservation and leak evaluations and audits.
- O. If you utilize a fixed base and hourly customer meter read system – investigate and consider an additional demand surcharge based on peak daily flows, which have a larger impact on a distribution or pumping system than annual or monthly volume usage (similar to what power utilities do with a demand charge).
- P. Investigate installation of real time leak detection monitoring equipment.
- Q. Consider new developments in master meter where practical.
- R. Investigate wastewater re-use systems and possible Membrane Bio-Reactor scalping plants to facilitate the irrigation of large institutional, agricultural, or private irrigation needs in adjacent areas.
- S. Provide optimum lawn watering and irrigation schedules to customers.
- T. Implement water theft regulations and provide the policing of such.
- U. Provide annual water loss reports to your public and board.
- V. Track what a system ERC standard really is, and trend regularly its claim on your water source capacity and water demand capacity.



- W. Understand better what water use is in the middle of night in the winter to estimate more accurately the background or passive water losses, etc.
- X. If possible – install meters in the low flow PRV by-passes which are constructed around larger PRV's, and are used more at low water use periods to help establish a system or regional base leakage rate.

V. Pumping System Efficiencies:

- A. Pumping system efficiencies are decreased if:
 1. The pump is operating outside of its pump curve efficiency range.
 2. The pump is worn or not of a proper design.
 3. The flow of water is restricted or throttled on the suction (and/or) discharge side.
 4. The electrical control system, i.e. VFD is not designed for the application. This is common in high head pumping systems where a VFD controls the whole flow in just a small band of Hz. VFD's are not always efficient in these cases.
 5. The Distribution System is not routing and controlling the flow of pumped water properly to its destination, i.e. re-pumping or short circuiting, faulty PRV's, etc. (see Modeling above).
 6. Other Distribution System Problems, i.e. storage issues, leaks, corrosion, pipe age and quality, under sizing, etc.
 7. Pump station pipe materials and fittings are corroded or tuberculated, increasing the friction coefficients.
 8. The electrical Load Factor is too low and the head losses on the distribution system are excessive. Load Factor (LF) is a fractional number or percentage indicating the average amount of time per day a motor or pump runs. i.e. a Load Factor of 0.25 or 25% means the pump runs on average 6 hours per day.
 9. The Electrical System Power Factor (PF) is not efficient or too low.
 10. The Water System Peaking Factor is too high (above 2.0).
 11. The Pumping Systems are not cooled properly.
 12. Metering issues, such as old worn meters, no master metering strategy, and no leak detection. etc.
- B. Pump Curves and pump performance should be regularly reviewed and tested. Test each pump on at least 4 points on the curve. Have a VFD curve available if the pump is on a VFD and test at several speed points.
- C. If you use the most economic utility power rate for your pumping systems, significant money can be saved.
- D. If you pump during the designated off peak periods of the Electrical Utility – you can also save money, by completely eliminating or reducing the Power Demand Charge. Adequate storage capacity is essential to follow this strategy.
- E. If you use Variable Frequency Drives (VFD's) to increase your Load Factor, or use jockey type pumps – you reduce your costs – by reducing your demand and energy charge.
- F. If you have a high head loss on a pump plant, a VFD can reduce your energy cost by reducing the total dynamic pumping head.
- G. If you are charged a power factor penalty – you can eliminate that charge by implementing power factor correction strategies.



- H. Pump cycles and operation should always be selected for efficiency, yet be prepared for any emergency operation scenario.
- I. Always match the VFD to the proper pump and pump curve.
- J. Never, ever use a restrictor valve to control the flow rate of a pump.
- K. Run pumps more often (prioritize) based on their costs per unit of water pumped, also referred to Specific Energy. If possible - choose the most efficient pumps first in a system for pumping.
- L. Carefully develop effective multiple pump rotation and lockout strategies.
- M. Provide for pump back-up strategies.
- N. Carefully review the necessity for pump trimming when using a VFD. Often the VFD acts as the pump trim.
- O. Evaluate multiple and smaller pump designs, vs. one or 2 large pumps in a pumping plant.
- P. Review well and pump designs to evaluate if a line drive pump is more efficient than a submersible pump system. Submersible motors are typically less efficient.
- Q. Implement SCADA and control system lockouts to prevent operators from running multiple pumps when not needed, or bumping pumps unnecessarily during an on-peak pumping period.
- R. Provide engineered pressure and surge protection systems to better protect distribution infrastructure and pumps from wear, breaks, leaks, etc.
- S. Provide or specify motor shaft grounding brushes to protect bearings on VFD operated pumps.
- T. Typically small jockey type pumps should run first and as long as possible to extend the load factors as much as possible. A load factor above 80 % is not unrealistic, in fact it is preferred.
- U. Regularly evaluate for service or replacement any old and worn pumping equipment.
- V. Use high performance lubricants on motors for extended performance and lower operating temperatures, and maintain levels.
- W. Well “pump to waste” cycles typically run pumps at their highest energy and power demands. Provide a back pressure or pressure sustaining valve in line with the pump control valve, or add a sustaining pilot on the pump control valve, to hold waste discharge pressures closer to the efficiency point on the curve. Ensure that these valves are not oversized. They should provide a significant back pressure simply as a function of their size. An alternative for a VFD controlled pump would be to run the waste cycle at a lower speed.
- X. Evaluate your pump exercise and water testing strategies. Avoid running a pump for a short period just to exercise it. If a pumping system needs this, evaluate running it in an off-peak period or on a generator regularly. The same applies to running well pumps for a simple water test, when they would normally be idle for a month or more.
- Y. Ensure that your well and well pump performance matches its design characteristics and pump curve. Also monitor well static and dynamic drawdown and specific capacity over time. If there are irregularities – the pump may be worn, or the pumping column may be leaking into the well annular space. When changing or servicing well pumps, perform a video inspection to ensure that the well casing is in good condition. A corroded or malfunctioning casing and screen system will restrict flow into the well casing and lower drawdown levels, thus increasing energy and power requirements.



- Z. In summary, implement water pumping and operational management strategies similar to the following:
1. Reduce Energy usage on pumping facilities by ensuring that pumps are not running at a level or in a configuration which increases head losses in the pumping or piping systems.
 2. Eliminating a possible return flow loop or leak in a pumping station through relief/surge anticipator valve(s) or emergency fire flow PRV's.
 3. Review pump curves to better limit Variable Frequency Drives (VFD's) to their optimum frequency range settings.
 4. Avoid "across the line" starters for motors where possible. Reduced Voltage Soft Starters (RVSS) and VFD's are usually better, depending on the application, and offer far better motor protection strategies.
 5. Monitor temperatures and environmental variables better in all pumping and other remote facilities to get better controlled energy use for heating and/or cooling. Use Motion detectors for lighting controls and install more efficient fluorescent (T5 or T8) or LED lighting.
 6. Evaluate and implement better and more efficient cooling systems for the larger pumping facilities, to not only save energy but extend pump life.
 7. Improve the efficiency and reliability of larger HVAC heating and cooling systems by, monitoring air pressures, humidity, and other parameters. And to better control operation in the winter months, using the heating systems only when needed. Integrate HVAC controls into PLC's and integrate with system SCADA equipment. Investigate using the water itself for cooling and heating (i.e. Water Furnace technology).
 8. Ensure where feasible, that pumps controlled by Variable Frequency Drives (VFD's) do not have their impellers trimmed – thus allowing for a wider range of operational flows and pressures.
 9. Large pump motors should be wound with RTD's (temperature sensors), and associated motor protection relays, to better monitor motor winding conditions.
 10. Establish Power Quality meters on larger facilities with daily SCADA logging capabilities.

VI. Storage System Efficiencies:

- A. Know all tank dimensions, including elevations of floor and overflow.
- B. Verify tank capacities and the capacity per foot.
- C. Know the equalization, fire, and emergency levels and capacities.
- D. Know your tank rate of changes +/- at all times with the SCADA system.
- E. With this information, make informed decisions, instead of relying on the classic "saw tooth" pattern of operation.
- F. With our unique ability to store water in tanks, we should think more of a tank as an energy storage battery, and use equalization storage in place of running pumps.
- G. Storing Water is very similar to storing energy, which in turn allows us:
 1. The ability to run high energy and power motors and other equipment at controlled rates, and
 2. During controlled periods of time.
 3. This is unique in the world of commercial and industrial power users.



- H. Size all new tanks for:
 - 1. Required ERC Demands as per State DEQ Standards, plus
 - 2. Fire and Emergency Storage, plus
 - 3. Energy Storage volumes (for Off-Peak Pumping) if possible.
- I. Inspect and clean all reservoirs regularly, check for leaks and security issues.
- J. Have a reservoir back-up plan in case a reservoir needs to be taken down, with PRV's, pressure regulated pumps or VFD's, etc.
- K. Install backup floats in reservoirs in case of transducer failures.
- L. Investigate possible ASR (Aquifer Storage and Recovery) projects to reduce the Seasonal Peaks, and better optimize the usage of water sources or treatment facilities.

VII. Distribution System Efficiencies:

- A. Ensure that all PRV's are properly maintained and tuned to provide optimum pressure levels which may in turn reduce accompanying distribution system water losses.
- B. Review fire hydrants annually and test for possible leaks.
- C. Keep a centrally accessible and well-maintained set of pipe location and leak detection instruments to ensure rapid and accurate assessments of infrastructure.
- D. Investigate installing a centrally located and efficiently accountable bulk water filling station for construction water – minimizing water losses and unauthorized use by contractors.
- E. Develop and implement a distribution system flushing program to ensure that water quality is maintained as well as friction losses minimized and water quality is optimized.
- F. Review and maintain key air-vac and air release devices in the distribution system to ensure that they are functioning properly with no build-up of air. This will maximize flow of water and can significantly decrease energy demands. Ensure that high points of distribution piping have air regulation devices. Even a partially air locked pipe can use significant energy in pumping.
- G. Where practical, install customer services in the top zone of distribution piping (and at pipe high points) to ensure air is kept out of the piping systems, and reduce the need for air-vac devices.
- H. To optimize energy efficiency on any raw un-treated water transmission lines – implement pipeline pigging programs to ensure that pipe wall friction coefficients are maintained at a minimum, thus reducing pumping energy costs.
- I. Model the distribution system using a steady state AND extended period models, to evaluate possible undersized piping systems and networks, including water flow patterns, water quality characteristics, and energy demands over different scenarios. (See Modeling above).
- J. Test water for possible tuberculation and corrosion (iron and sulphur reducing bacteria, and Langelier index) issues which can impose energy inefficiencies.
- K. Be careful not to crush PE piping in new piping installations.
- L. Investigate the installation of real time pressure transducer monitoring at key distribution sites and use the data to calibrate system models.
- M. Implement and monitor Backflow testing programs to protect water quality, and ensure that these protection devices are not leaking.



- N. Check the distribution system(s) for partially closed or lost isolation valves. Know the valve rotation counts for various diameters of pipe. Verify these diameters with the piping models and record drawings.
- O. Investigate pipe network looping and additional network upgrades in the system to reduce head losses on pumping systems, etc.
- P. Specify pipe materials which have a higher “C” coefficient in future upgrades or expansions.
- Q. Incorporated pressure management PRV control valve systems where practical. These systems can drop the pressure from say, 110 psi to 70 psi during low demand periods, which helps to reduce water use and lower the leak rates. It also limits the wear and tear on the water system. But when higher flows are needed in that zone, the pressure automatically increases to the higher pressure for such use as fire-flow or heavy demand. When demand subsides, the valve automatically returns to the lower settings.
- R. Develop an upgrade plan for piping systems which are deficient in size, materials, or quality.

VIII. Plant or Treatment Facility Efficiencies:

- A. Upgrade key chlorinating disinfection units to more efficient systems, utilizing less energy either in production and/or transportation and handling of product.
- B. Investigate chlorine generation systems. We live in a State with accessible and cheap salt deliveries, making the electrolytic generation of chlorine much more efficient.
- C. Implement more natural and energy efficient systems to reduce algae growth in raw water systems, which could reduce the costs and amount of chemicals used for treatment.
- D. Improve treatment plant process control and efficiency through proper utilization and dosing of chemicals to reduce chemical waste, etc.
- E. Improve chemical storage to increase bulk purchase discounts and reduce delivery frequency thus saving energy and costs.
- F. Monitor electrical facilities for inefficient heat dissipation or cooling, through increased building insulation, etc.
- G. Use more efficient lighting in plants (i.e. T5 Florescent or LED).

IX. Technology and SCADA Efficiencies:

- A. Key to the operation of a successful advanced energy management strategy is the close and persistent review of pumping and energy data. While many SCADA systems are adept at general plant operations, an advanced system requires more analysis of the situations at hand, and must make more complex decisions, as well as provide more comprehensive reporting and alarming features. We call this SCADA 2.0. Presented below are some of the SCADA 2.0 process and related control strategies:
 1. **Typical** - SCADA operation based on the usual reservoir set points
 2. **Off Peak Mode** – Run everything off-peak if reservoirs allow (can eliminate power charge – Rocky Mountain Power (RMP) Rates 6B, 8, 9, or reduce energy charge – Rate 6A).
 3. **Off Peak - Load Factor Mode** – Run everything off-peak if reservoirs allow, but pump the entire off-peak period at lower flows (can eliminate power charge – RMP Rates 6B, 8, 9, AND reduce energy charge for all rates.)



4. **Load Factor Mode** – Fill the entire day with as few of pumps as possible (or run smaller pumps) or reduce Hz on VFD’s (can significantly reduce energy charge AND power charge).
 5. **Efficiency Failover Mode Option** - If #2 or #3 fails – then switch to #4, Additional Option - If #4 fails –then switch to #1.
 6. The SCADA system reviews continuous pump efficiency, with GPM per kw, and gallons per kwh (or kwh per MG), as well as Power Factor monitoring data and presents historical trend charts and alerts. (Note: some power and energy monitoring equipment upgrades may be necessary).
 7. Provides detailed reports to alert for possible water loss, problems, etc.
- B. Implement energy and power monitoring reporting (i.e. Specific Energy and Power) into the SCADA system to better monitor the performance of pumping systems. This will allow for more rapid reporting of pump failure or blockage by rocks or debris in an impeller or impeller wear, significantly reducing its efficiency, or motor malfunction.
- C. Through the proper implementation of an Asset Management system and a GIS system – provide geographically accurate infrastructure information and maintenance history to empower staff with the data necessary to make timely repairs, reduce travel, and improve maintenance decisions.
- D. Have proper power backup generators and equipment available so key infrastructure can be operated in an emergency. Backup all SCADA, security, and critical control systems at key locations using a small backup generator and/or UPS system if necessary.
- E. Move more critical computer server applications into the “cloud” as they become available and more mature, reducing local costs of hardware management, software maintenance, as well as energy costs, as well as providing better data backups.
- F. Install “water bug” type water leak detection devices on all SCADA sites to enable staff to react quickly to any type of facility leak or water loss promptly.
- G. Develop and practice backup procedures for failed SCADA system(s) (i.e. communication loss plans), etc.
- H. Basic SCADA reports:
1. Daily Consumption – net reservoirs, etc.
 2. Hourly Consumption as above.
 3. Pump performance data.
 4. Power quality data.
 5. USE the SCADA data gathered efficiently and properly.
- I. Important SCADA Efficiency Data to gather at plants and pumping facilities:
1. Amps
 2. Volts
 3. VAR’s
 4. Kilowatts
 5. Kilowatt hours
 6. KVAR hours
 7. Power Factor
 8. THD
 9. Well drawdown
 10. Well Specific Capacity Calculation; gpm / foot



11. Specific Power Calculation; kw / gpm or mgd
12. Specific Energy Calculation; kwh / gallon or KG or MG
13. Rate cost data - What does a pump cost per day, month, year, etc.?

- J. Tie real time SCADA data into a dynamic water model.
- K. Tie real time SCADA data into an asset management or work order system, where work orders are issued automatically based on equipment run metrics, i.e. run hours, gallons pumped, etc.
- L. Record system pressures at key points and in PRV stations, etc. See real time performance in emergencies, pipeline breaks, etc. pinpoint trouble areas for potential cross connections, etc.
- M. Provide higher levels of infrastructure security and intrusion detection. Use IP video in high risk areas.
- N. Using the above data and resources - predict areas for future improvements and repairs.

X. Internal or Operational and Behavioral Efficiencies: This section describes energy efficiency strategies that can simply be achieved by management or operation changes in the way we function in the workplace. Many of these strategies require very little money or effort to achieve a savings.

A. Sustainability - Review State and EPA Standards for capacity development in the following areas and implement the standards:

1. Managerial Capacity
2. Financial Capacity
 - a. Effective Rates
 - b. Impact Fees
 - c. Levels of Service standards
3. Technical Capacity

B. Train and Educate – Provide training opportunities for administrative, office, and operational staff at regular intervals. Ensure that all personnel are certified at levels at least at their required proficiency requirements. The Rural Water Association of Utah and the State Division of Drinking Water offer many courses and testing opportunities.

C. Administrative:

1. Know who to call when help is needed. Have a ledger distributed to all departments of who to contact in an emergency or if technical assistance is needed. Again, the Rural Water Association of Utah and the State Division of Drinking Water have resources in place to help with any type of problem or assistance needed.
2. Develop a realistic capital improvement program to replace old systems with more efficient systems.
3. Implement efficient Utility Billing and related financial data systems.
4. Develop sound emergency management programs, including redundant communication systems for SCADA and personnel access.
5. Join the UT-WARN cooperative agency to provide resources in an emergency or other problem.



6. Implement Asset Management Systems for:
 - a. O&M
 - b. Capital Improvements

D. Operational:

1. In large utilities, geographically distribute operational personnel where practical. Create possible small satellite offices or shops and equipment stores, with SCADA access to more efficiently position operation staff across the service area.
2. Train operators regularly in the efficient and proper diagnostic procedures used to determine system water losses.
3. Reduce paper output by providing work orders, system maps, O&M manuals, and system photos digitally to remotely accessible computers and mobile devices (iPads, smartphones, etc.).
4. Optimize and centralize spare parts and other inventory in key locations to reduce energy and time related travel needed for the proper operation and maintenance of the systems assets and services.
5. Ensure that all operations and management staff have reliable access to SCADA, security systems, and server data and resources to minimize the amount of travel need to check systems in person.
6. Encourage telecommuting with certain staff where practical.
7. Compile and regularly train with employees or operators “Water Operations Manuals” or “Standard Operating Procedures” (SOP’s) – compiled with emergency and energy management procedures, etc.
8. Practice “table top exercises” and drills and tests, etc. in company operation and emergency procedures.
9. Teach operations staff to be creative and innovative, and provide new ideas and designs. Reward for such.

E. Office Facilities:

1. Implement Energy management strategies in water system offices – i.e. programing thermostats effectively and using low energy lighting, motion controlled light switches, etc.
2. Install a backup generator for the administrative office if needed.

F. Public Relations and Education:

1. Make the system’s WEB Page more public friendly, usable, and efficient.
2. Education (start early to instill a conservation ethic in children):
3. Conservation Resources
4. Water Fairs
5. Back-flow and cross connection prevention
6. Groundwater protection
7. Conservation Garden(s) and xeriscaping displays
8. Public Educational Press Releases
9. Educate the public to assist in the recognition of a water leak, possible security breach, or water theft, etc.

G. Materials and Equipment Recycling:

1. Recycle paper and other appropriate office items. Provide accessible bins for such purposes.





2. Recycle used metal scrap, copper, brass, (meters) and bronze, from old water facilities, equipment, and meters.
3. Re-use older electrical and water distribution equipment where feasible.
4. Recycle all SCADA and UPS system batteries.
5. Recycling programs for pipe, copper, brass and other materials
6. Implement the proper re-use of used materials in bone yards, etc.

H. Fleet and Transportation:

1. Reduce fuel usage by operations staff through the proper implementation and use of a field accessible customer service order, asset management system, and inventory control system. This will significantly reduce the need to return to the office frequently to gather work orders, directives, etc.
2. Procure more energy efficient vehicles and equipment in system operations.
3. Investigate CNG conversions for viable equipment.
4. In very large systems, investigate the use of GPS tracking on company vehicles to assist in the most timely and efficient dispatch of personnel to customer needs or equipment problems.

I. System Regionalization Efficiencies:

1. Can provide some economies of scale.
2. Allows for the shared source and storage facilities and extends capacities.
3. Lower staffing levels per customer.
4. More efficient use of heavy equipment and repair parts inventories.
5. Regionalizing can sometimes be inefficient regarding energy due to the interconnection of systems that were not designed for such.

XI. Energy Supply, Timing, Control, and Backup Efficiencies: NOTE: much of the data gathering and field work necessitated by this section should be performed by qualified personnel, who are adept at electrical safety and arc-flash procedures:

- A. Carefully select the appropriate utility energy rate for the pumping application (See section XII below).
- B. Pumping Selections should be based on unit water costs. Know the Specific Power cost per ac-ft/year, mgd or gpm. Also know the Specific Energy cost per KG, ac-ft, or MG.
- C. If it is not an emergency - make all motor operation selections for efficiency rather than economy.
- D. Evaluate Conventional vs. Off-Peak Pumping in systems using the following criteria:
 1. Electrical Power systems size power generating and delivery systems using the same concepts of a water system.
 2. Power plants are sized to meet the peak daily energy and power load of their users, even if for a very short time.
 3. The art of energy conservation is based on reducing the overall peaking factor of a system, thus reducing peak generating demands, brown outs, rolling blackouts, and minimizing the carbon footprint of a power system.
 4. The SMART energy grid is an attempt to reduce adverse peaking impacts.
 5. Peak water demands like power deliveries are the most costly.
 6. Peaks require the greatest usage of resources.



7. Peak demands rob a system of customer growth capacity – whereas reducing the peak through conservation allows for the economic servicing of more customers with fewer upgrades.
8. Peak demands increase O&M on a system.
9. Peak demands also have a greater impact on the environment.

- E. Evaluate the pumping plant Load Factor – using the following criteria:
1. Load Factor is a measurement of the amount of time a facility runs during the billing cycle or during the average day. A large part of an electrical bill is the demand or peak power charge, and if a pumping system runs at a high capacity for a short time – the peak power (kw) charge is assessed – on as little as a one minute pumping period.
 2. The Load Factor (LF) on a pumping system also has a big impact on monthly power rates.
 3. If the pumping system can run longer – say 80% or more of the time, at a lower capacity – the same amount of water is pumped during a day or month, but the peak power charge is much less.
 4. LF is expressed as a fractional number or a percent (%), where 100% means the pumps run 24/7. 50% means they run half of the time during the billing period, average day, etc.
 5. Most pumping facilities are designed inefficiently to run for short periods normally, around 25% LF or less, and cost considerably more to run.
 6. They are also designed so longer run periods are saved for emergencies or build-out.
 7. A VFD can have a big impact on Load Factors if run correctly, and can save on motor maintenance and efficiency as well.
 8. A small jockey type pump or pumps can also increase the Load Factor.
 9. An ideal Load Factor would be 80 percent or above.

- F. Low Power Factor (as opposed to Load Factor), which is caused by an inefficient pumping system can also significantly increase electrical inefficiencies and may result in an electrical utility penalty. The power factor decreases as more reactive power is utilized in a system (VAR's). Reactive energy can be reduced generally by adding capacitors to a circuit or utilizing VFD's.

- G. Energy Savings and a VFD:
1. Besides saving Power in a pumping system as previously explained, VFD's can also be utilized to save energy (kwh). This can be a significant savings in some systems.
 2. Many pumping systems are pumping too great of a flow in a restricted piping system and the head losses can be significant, i.e. improperly sized pump to pipe system.
 3. Other pumping systems are using a valve to restrict the flow in a pumping system to accomplish the above.
 4. Imagine driving down the road at 100 mph, and while keeping your foot at the same position on the accelerator, stopping or slowing down your speed with your brake. You consume the same amount of energy but instead of using it, you are burning it up in your braking system.





5. This is similar to the energy losses in a system that restricts flow with a valve.
6. A VFD can save considerable energy by replacing the valved system or restricted distribution piping. It can run pumps for a longer period at a lower flow (similar to the power savings above).
7. This solution can result in energy savings as well as power savings.
8. VFD's do not ALWAYS save energy however, and are not always ideal for some pumping systems, namely high head systems which have a large static head to overcome.
9. VFD's can also add extra heat to a pumping system.

- H. Soft Start's or Reduced Voltage Soft Starters – (RVSS) can be a viable alternative to a VFD, where a VFD is not an efficient alternative. RVSS reduce the peak loads and stress on a starting pump, and also contain valuable motor energy and power data, which is useful in an advanced SCADA monitoring and control system. They also run cooler and can significantly outlast an across the line starter.
- I. Regularly review plant Wire to Water Efficiencies.
- J. Test for Harmonics on VFD pumping systems and remedy with properly sized filtering systems. Many newer VFD's come with these features.
- K. Ensure that plant motor and VFD equipment is properly and efficiently cooled.
- L. Have a Back-up Power System program and optimize any generator efficiency. Conserve potential generator use. Generators should start remotely, based upon one of the following selector switch positions in the control system:
1. Auto Lock Out - meaning that the generator fuel will not be used,
 2. Auto Start in Outage - meaning that the generator will switch on whenever the power goes off, and
 3. Auto Start Pump Call - meaning that the generator fuel will only be used when the reservoir calls for water, and the generator will automatically shut off when the reservoir is full. This is designed to conserve fuel during emergency situations. Diversify generator fuels, with some using diesel fuel, and some using natural gas and propane. Have a diversity of types, stationary and mobile, and do not oversize them. VFD pumps take less starting capacity. Some starting capacity can be saved by starting at shut-off heads against a closed valve.
- M. Utilize Solar Cells and battery (UPS) on SCADA systems to keep the data transmitting during a power outage and protect security.
- N. Implement security systems to protect water quality and quantity.
- O. Incorporate energy management and operation of back-up systems into your emergency preparedness and response systems.
- P. Investigate using a small solar powered DC/AC well for long term emergency water (if only 1 gal per person per day), with portable tank if needed. A 10 gpm well, run for 12 hours per day will supply 7,200 people.
- Q. Provide a good backup supply of key equipment to promptly implement repairs and save water, i.e. transducers, SCADA equipment, pumps, valves, repair parts, etc.
- R. Provide advanced Power Quality Monitoring equipment at pumping plants (on either a per pump basis or per plant basis) to assist in the diagnosis of pump problems, etc.



- S. Perform regular Infra-Red (IR) camera tests on electrical facilities to determine any potential thermal electric problems with motors, transformers, breakers, electrical connections, etc.
- T. Building and plant design and energy efficiency.
 - 1. **Insulation.** Concrete is not a good insulator in and of itself. Insulate the outside buried portions with protected insulation. Where above ground, insulate the inside.
 - 2. **Lighting.** Review HO T5 and LED lighting options. Standardize on one system. Skylights can be valuable in certain situations. Security may be a concern with these however.
 - 3. **HVAC** – This can be very significant. Electrical resistive heating systems can often have kilowatt loads higher than even some of the pumping systems (3-20kw per heater!). If this is the case – seriously look at other alternatives for heating and/or cooling. A small loop of water run through a coil and supplied around a pump system can supply significant cooling potential, and even possibly some geothermal heating solutions. Review shallow geothermal (sometimes referred to as geo-exchange) options where you use the water itself for heating and cooling - see the water furnace systems at www.waterfurnace.com for some ideas. Review solar thermal systems for day-time heating. These can be coupled with geothermal systems as well.
 - 4. **Humidity** - Moisture from condensation can be a problem, especially if a pump or plant air is overheated. Review economical humidity control systems. Proper ventilation can be important as well. Air heat exchangers can be used in some situations.
- U. Keep all electrical and control equipment clean.
- V. Keep accurate records for daily, monthly, and annual water use at source and demand facilities, also calibrate to correspond to energy billing periods.
- W. Large energy accounts should be subscribed with the power company for on-line access, for daily review, reports, etc.
- X. If you use off-peak power strategies, check utility energy meters regularly to ensure that they are synchronized with the correct time. Always leave a small time buffer on your start and stop times.
- Y. External Energy Service Provider Strategies:
 - 1. Ensure key facilities are accessible to outside utilities in all seasons to guarantee that meters are read in an accurate and timely fashion and not estimated. Estimates eliminate much of the benefits to off-peak strategies or low load and high load factor strategies.
 - 2. Perform regular utility bill audits. Record and log power and gas consumption data as needed to ensure accuracy in billings as well as facilitating reliable budgetary projections.
 - 3. Graph energy and gas use to demonstrate success of conservation and management strategies.
 - 4. Eliminate small unnecessary or redundant electrical accounts – replace with solar systems if and where feasible.
 - 5. Investigate net metering opportunities on smaller accounts using solar, wind, or energy recovery generation devices or other similar and authorized equipment



- Z. Investigate the Rocky Mountain Power (RMP) Watt Smart program for possible incentive funding of energy saving and management projects. This requires an analysis – performed and funded by a RMP authorized consultant, but if a real and verifiable energy savings can be obtained, the Watt Smart program will provide financial assistance to achieve the same. These projects can provide a significant savings on high energy projects such as pumping systems as described in this document. Any energy saving project you anticipate should be reviewed with your RMP customer service representative prior to its design and implementation.

AA. Potential energy sources and Net-Metering opportunities:

1. Natural Gas / Propane:
2. Diesel with proper air quality equipment
3. Solar Electric
4. Solar Thermal
5. Geo Thermal
6. Wind
7. Energy Recovery at PRV's, i.e. Small or Micro Hydro, etc.

XII. Energy and Power Rate Dynamics. This section describes many of the key energy and power tariffs, regulations, and operational opportunities available to Rocky Mountain Power (RMP) customers. These regulations may be similar to those water utilities which are supplied by local Municipal Power Systems. Check with their local tariffs and regulations to properly review any differences.

- A. Commercial tariffs commonly used in the water supply industry (NOTE: Rates can be changed, but not more than once per year):
1. **Rate 23** – small Commercial – low demands < 30kw, this is typically the highest unit cost rate for water production.
 2. **Rate 6** – Commercial – medium demand < 1 mw (most common pumping rate).
 3. **Rate 6A** – A commercial time of day energy rate. If you have a low load factor – you can save on this rate. It also has an off peak rate built in to it.
 4. **Rate 6B** (see note *) is the Rate 6 power time of day off-peak rate.
 5. **Rate 8** – Large commercial / industrial rate > 1 mw. Slightly lower rates but the off-peak period **DOUBLES** in the summer months from 8 hours to 16 hours per day!
 6. **Rate 9** – Large industrial transmission rate. Should be considered if loads are consistently above 1-2 mw. Considerably lower rates and off peak periods are the same as rate 8, but you need to take the service from a transmission line at the high voltage side, 46kv and above, and you must construct, own, and operate a sub-station.
 7. **NOTE ***: Rate 6B has a 12 month averaged minimum kw (look-back) – prior to the 6B Election. Be careful and practice for a year before electing this rate (try to get on-peak loads as low as possible)! **OR** –start a new facility with this rate if you are going to go Off-Peak.



- B. Off-Peak Power periods:
1. 11:00 PM to 7:00 AM all year
 2. All day on weekends and major holidays.
 3. For Rate 8 and 9 Customers they are:
9:00 PM to 1:00 PM in the Summer Months, and
11:00 PM to 7:00 AM in the Winter Months.
All day on weekends and holidays
Summer months are May through September
 4. Remember that you lose most of the power demand savings if you go on peak for even a minute (except Rate 6A).
- C. Off-Peak Considerations and Implications:
1. Beware of Rate 6B –with Great Savings comes Great Responsibility.
 2. Carefully control water source tests or pump exercise schedules.
 3. Check power meter clocks at least annually and provide a small time buffer in your run schedules.
 4. Study the Rate Tariffs REGULARLY! They change without notice.
 5. Understand the fine print in the tariffs regarding the “Daylight Savings Time” Challenge! This requires several more schedule changes than you think because RMP still programs their meters using the OLD Daylight Savings Time annual schedules. A mistake here can be costly. The current wording is as follows: “Due to the expansions of Daylight Saving Time (DST) as adopted under Section 10 of the U.S. Energy Policy Act of 2005 the time periods shown herein (Off-Peak) will begin and end one hour later for the period between the second Sunday in March and the first Sunday in April, and for the period between the last Sunday in October and the first Sunday in November.”
- D. Larger User Implications. The Off-Peak rate for rate 6 and the rates 8 and 9 look similar, but the following needs to be remembered:
1. The Off-Peak periods for the number 6 rates (6A and 6B) can never go more than 8 hours per day.
 2. The Off-Peak periods for the 8 and 9 rates go to 16 hours per day in the summer.
 3. Many pumping systems may need to go partially ON-PEAK in the peak months to meet the daily and monthly demands of the system when the limitation is only 8 hours per day.
 4. If you have the ability to use 1 mw – you may want to consider a forced change to Rate 8 (pay a large power penalty at first) to enjoy the benefits of a longer off peak summer period (study carefully). This trick would need to be done at least once annually, preferably in the winter months before May.
 5. The extended off peak period makes the savings for rate 8 and 9 larger than may appear, since the Off-Peak periods will likely be maintained in the peak months.
- E. A Conservation - Savings Management Cycle (The greater the effort – the greater benefit):
1. **Easy** – If you have low LF, (<50%) move to rate 6A.
 2. **Moderate** – Stay on rate 6 and Increase your LF or pumping efficiency by:



- a. Managing your control scheme better (SCADA)
- b. Installing VFD's on pumping systems (RMP may help pay!)
3. **Harder** – Move your rate to 6A and shed your energy loads to Off-Peak periods.
4. **Hardest** – If you are a large user –Move to rate 8 or 9 and go Off-Peak as much as is possible. Use high pump loads Off-Peak and reduce loads On-Peak – with large Load Factors. And investigate ASR and Energy Recovery.

- F. The Energy Rate and Load Factor Dynamic:
1. Rate 6A is more economical for a low Load Factor (<50%).
 2. Rate 6 or 6B is more economical for a higher Load Factor (>50%).
- G. Estimated utility energy reads (where a power utility cannot read a meter due to access or weather conditions) can kill any off peak pumping strategy. They do not account well for uses at differing periods of the day. They also can have an impact on high load factor strategies. If this becomes common, particularly in the winter months, see if a continuous remote read system is available from the utility. It may cost a little more a month but the savings can be much more significant.

XIII. Engineering and Design Efficiency Goals:

- A. Ensure that all new water storage and pumping facilities are designed and sized with off-peak pumping demands in mind.
- B. Study potential ASR programs (Aquifer Storage and Recovery), including possibly other similar groundwater programs to reduce the peak pumping and treatment load on the company facilities in the summer months.
- C. Study other possible major surface water storage projects to reduce the peak capacity of secondary systems if applicable.
- D. Study where hydro-electric energy recovery may be implemented at large pressure reduction locations or other storage locations. Situate key PRV's near power infrastructure if possible. Also – locate PRV's in plants or pumping stations if they are adjacent to the same.
- E. Investigate the possibility of incorporating wind and/or solar energy systems to facilitate net metering opportunities near plants or other facilities.
- F. With mature GIS data – computer model the distribution systems to find areas or facilities that may be inefficient or undersized, decreasing possible water losses and pumping demands.
- G. Provide workable and dynamic water models to staff and train in the proper use thereof, i.e. EPANET systems.
- H. Study water sources and pumping facilities to find the actual energy and power costs per ac-ft or mg. The company can then develop a strategy to pump water from more efficient pumping systems and also shut down or mothball facilities that are inefficient or redundant.
- I. Make the SCADA system smarter. Monitor areas for real-time water losses and pressure changes.
- J. Model the system to test for efficiencies in pumping, distribution, and storage systems.
- K. Automate meter reading and billing systems, upgrade meters if needed.
- L. Choose the correct power rates for each service and design the facility for such.
- M. Enlarge water storage systems if possible (require more of new developers).

- N. Pump OFF-PEAK as much as practicable.
- O. Improve the water distribution system where needed.
- P. Design pumping plants with more and smaller selectable pumps and motors, or with larger motors on VFD's.
- Q. Consider a Seasonal 2 Stage pumping system with smaller pumps in the winter and larger pumps in the summer.
- R. Use a VFD rather than a restricting valve – or change out the pumps.
- S. Increase sizes of transmission lines or loop distribution lines if pumping head is too high on a pumping plant.
- T. Correct power factor on accounts that are penalized.
- U. Investigate the Industrial Rate 9 feasibility on large projects.
- V. Implement a regular water and energy audit program.

Definitions of Terms Used in this Document:

Acronyms	Meaning
A/C	Air Conditioning
AC	Alternating Current
ac-ft	Acre Feet (a volume of water covering an acre a foot deep (43,560 cubic feet))
air-vac	Air vacuum valves
ASR	Aquifer Storage and Recovery
AWWA	American Water Works Association
C	The discharge coefficient used in the Hazen Williams equation of flow (the higher the C value the higher the flow through a pipe)
CNG	Compressed Natural Gas
DC/AC	Direct Current / Alternating Current
DEQ	Department of Environmental Quality
ERC	Equivalent Residential Connection
ET	Evapotranspiration
gal	Gallons
GIS	Geographic Information System
gpm	Gallons per minute
GPS	Global Positioning Systems
HGL	Hydraulic Grade Line
HO	Harmonic Oscillator
HVAC	Heating, Ventilating and Air Conditioning
Hz	Hertz (a measure of the cycles per second – used with electrical equipment)
IP	Internet Protocol
IR	Infrared
KG	1,000 gallons
kw	Kilowatts – the primary unit of Power
kwh	Kilowatt Hours – the primary unit of Energy usage.
KVAR	1,000 VAR's. See VAR below
KVARHr	The portion of energy usage attributed to reactive energy.
LED	Light-emitting Diode
LF	Load Factor (the measure of a time a facility runs during a billing cycle)
MG	Million gallons
mgd	Million gallons per day
mw	Megawatts
O & M	Operation and Maintenance
PCV	Pressure Control Valve
PE	Plain End or Professional Engineer
PLC	Programmable Logic Controller
PRV	Pressure Reducing Valve
RMP	Rocky Mountain Power
RTD's	Resistance Temperature Detectors (temperature sensors)
RVSS	Reduced Voltage Soft Starters
SCADA	Supervisory Control and Data Acquisition (Water system operation)

	automation)
SMART Energy Grid	A method by which energy suppliers can monitor and control energy loads, such as reducing AC loads during the peak periods of the day.
THD	Total Harmonic Distortion
UPS	Uninterruptible Power Source
VAR	Volt-Ampere Reactive, a unit of reactive power in an electrical system. Reactive power exists in an AC circuit when the current and voltage are not in phase.
VFD	Variable Frequency Drive

3. Funding Opportunities

A. Drinking Water Board The Drinking Water Board administers the State's Revolving Fund which provides financial assistance to public drinking water systems for water project construction. The Division of Drinking Water (the Division or DDW), acting as staff to the Drinking Water Board (the Board), provides oversight to the Drinking Water State Revolving Fund (DWSRF) financial assistance program. The DWSRF provides financial assistance to public water systems for planning, designing and constructing improvements to drinking water system infrastructure. This section of the Guidance Document provides an overview of the DWSRF application process.

The application for financial assistance, for either planning or design and construction projects, is available from the Division's internet web site at:

http://www.deq.utah.gov/FeesGrants/funds/drinkingwater/state_srf.htm

The Drinking Water Board meets at least six times per year. A schedule of upcoming meetings, along with application deadlines, is also available at this web site:

http://www.deq.utah.gov/FeesGrants/funds/drinkingwater/state_srf.htm

The completed application must be submitted to DDW prior to the deadline for the specific meeting you wish to attend, as listed in the schedule. A complete application is a critical part of an accurate evaluation. Please be sure to fill in each section of the application with as much information as possible. Division staff are available to answer any questions about the application, the application process, or the DWSRF program in general.

Division staff will review the application and evaluate the project to determine its feasibility. A major part of the evaluation focuses on affordability and staff uses financial information provided by the applicant to determine an appropriate financial assistance proposal to present to the Board. Under specific circumstances an applicant may qualify as a "disadvantaged community" and may therefore be considered for subsidies under the DWSRF program. These subsidies can take the form of a lower interest rate and/or grant/principal forgiveness, either of which will lower the overall cost of borrowing money to complete the project.

Once financial assistance has been authorized by the Board, staff works with the applicant to meet the requirements to close the loan and make the money available for construction. The loan closing process is extensive and can take several months to complete. This timeline must be taken into consideration when a water system is planning a project.

A more detailed overview of the state's Financial Assistance Programs is available here:

http://www.deq.utah.gov/FeesGrants/funds/drinkingwater/state_srf.htm

B. Utah Office of Energy Development The Utah U-Save Energy Fund Program (“U-Save”) finances energy-related cost reduction retrofits for publicly-owned buildings, including: state, tribal, municipal (city and county - which can include publicly-owned drinking water systems), public school districts, charter schools, public colleges, public university facilities. Through U-Save, low interest rate loans are provided to assist these institutions in financing their energy cost reduction efforts. Because this is a revolving loan fund, U-Save permits borrowers to repay loans through the stream of cost savings realized from these projects. Also because it is a revolving fund, the availability of funds may have to wait for fund repayments by previous applicants.

All U-Save projects must be analyzed by a Professional Engineer who meets the criteria outlined in Section II of the U-Save Program Guidebook (available on the Office of Energy Development (OED)’s website listed in the Appendix C of this document). Project descriptions and calculations are presented in an Energy Assessment Report (“EAR”), which is then reviewed and approved by the OED’s technical staff before project financing is authorized. Projects financed by U-Save must have an average simple payback of five years or less. In the alternative, borrowers have the option of “buying down” paybacks to meet the five-year limit.

U-Save funds are available to retrofit existing equipment and installations. In identifying potential projects, technical analysts are encouraged to evaluate renewable energy technologies as well as more traditional energy retrofits. Such projects may include rooftop solar, water and space heating systems, electric generation with photovoltaic or small wind systems, or hydro-electric projects.

Following the approval of the borrower’s loan application by OED, project designs are reviewed and monitored during the construction phase, as well as at project completion. The process for designing and implementing the project(s) approved for the borrower includes several milestones:

1. *Selecting a design engineer.* This can be the same engineer who prepared the EAR – however, the borrower must follow competitive procedures (unless the borrower has an engineer under an existing contract – e.g., the City Engineer).
2. *Preparing the design documents.* To ensure that the design specifications match the projects identified in the report, the OED technical staff will typically prepare the following reports: (1) Design Development Report (“DDR”); and (2) Detailed Design Review Report (“DDRR”). The DDR will be completed when the design process is approximately 50% complete and will verify that the design is proceeding in a direction that conforms with the EAR. The DDRR will evaluate the proposed schedule and estimated project construction budget provided by the design engineer.
3. *Bidding the work.* Borrowers must competitively select contractors or bidders as required by state law.

4. *Installing the projects.* To ensure that the work meets all technical and state requirements, OED will perform a construction monitoring visit at least once while the work is in progress.
5. *Closing out the project.* Upon completion of the project, the borrower will submit a Final Completion Report to OED.
6. *Repaying the loan.* OED will forward an Amortization Schedule to the borrower based on the incurred loan amount. Loan repayments will begin within 60 days of project completion and are due quarterly. The amount of annual loan repayment is based on the energy cost savings projected in the EAR. The typical borrower is obligated to repay the loan in 20 quarterly installments over a five-year period.

Post-retrofit energy savings should be monitored by the borrower to insure that energy is being conserved and energy cost savings are being realized. The level of monitoring can range from utility bill analysis to individual system or whole building metering, depending on the size and types of retrofits installed. Additional funds can be borrowed for the metering of large, complex retrofits. Loans are also available for systems considering to maximize the probability of achieving, or exceeding, calculated savings.

While the U-Save program is designed for retrofits to publicly-owned *buildings*, water system-related improvements may be included in these retrofits. Examples of potential retrofits include, but are not limited to, improvement to heating and cooling systems within water system buildings, and:

1. Replacing constant speed motors with variable speed motors or soft start motors
2. Replacing strategically located undersized pipelines or leaking pipelines with new adequately sized pipes
3. Adjusting and/or installing SCADA systems to maximize pumping during off-peak time periods
4. Replacing pumps: a) with worn out impellers, or b) operating outside its pump curve efficiency range.

C. Energy Service Companies: Energy performance contracting is a method of procurement that enables public entities to select a partner in making energy efficiency improvements to their facilities, without the need for capital expenditures. Enabled in Utah by the State legislature, (Utah Code 11-44), this method of construction has three significant requirements: 1) Annual savings must exceed annual project repayment cost, 2) Guarantees are required to ensure savings, and 3) Annual reporting is required to verify savings are being realized. These requirements protect the interests of the public entity.

Siemens will evaluate a process and if there is an opportunity for the public entity to save money, will design, build and operate the facilities to ensure its success. The public entity will then apply the savings from the improvements toward project repayment over the repayment term.

As mentioned previously, by state statute, all projects must be cash flow positive each year during the project repayment term. The public entity will receive the difference between the annual savings and the annual project repayment costs. Upon complete payment, the public entity will take over the operation of the facilities and reap the full annual savings thereafter. The provisions of the State law protect the public entity. The State also maintains a list of pre-qualified Energy Performance Contractors.

D. Rocky Mountain Power’s Wattsmart Program Rocky Mountain Power offers a variety of ways to assist customers in maximizing the efficient utilization of electricity. Customer participation is voluntary and is initiated by following the participation procedures on the *wattsmart*® Business section of the Company website at wattsmart.com.

The *wattsmart* Business program offers a variety of services and cash incentives to encourage Rocky Mountain Power commercial, industrial and agricultural customers to build energy efficiency into their businesses. Retrofit and new construction projects can receive cash incentives for the implementation of approved energy efficiency measures. Typical upgrades, common in most buildings or businesses, have a pre-determined incentive value and can be found at rockymountainpower.net/utincentives.

Custom projects, such as those associated with water systems, are outside the scope of typical upgrades on the incentive lists. Rocky Mountain Power customers can benefit from the technical expertise of energy experts who will evaluate electric energy-saving options and estimate savings. Incentives for custom projects are \$0.15 per annual kilowatt-hour savings, not to exceed 70% of eligible project costs for projects that meet simple payback period criteria. Customers looking at custom projects must contact Rocky Mountain Power before equipment is purchased to confirm that it qualifies for the custom incentive.

Beyond typical and custom incentives for energy-saving projects, Rocky Mountain Power non-residential customers can also benefit from guidance on day-to-day energy management of their systems. Customers can receive potential incentives of \$0.02 per kilowatt-hour for verified savings of energy management measures. Visit rockymountainpower.net/utsave and select the Energy Management icon to learn more.

To participate in Rocky Mountain Power’ energy efficiency programs, visit wattsmart.com and inquire online, email wattsmartbusiness@rockymountainpower.net or call toll free at 1-800-222-4335. As a reminder, contact the company early, before projects are initiated to confirm the project meets program criteria and eligibility

E. Self-funding through Energy Savings Some communities may be able to self-fund energy efficient projects. This is typically done with a fund within the City’s budget that is not needed for a couple of years. The responsible party of the fund (let’s call it the “Agency Fund”) will arrange to invest its money into the City’s water fund to build the energy saving project, and the Agency Fund will increase as an interest bearing investment. To accomplish this, the water fund

will pay back the loan with monthly or yearly payments. The period of the loan, or its time duration will be within the time constraints of the Agency Fund. The City’s water fund will make payments to the Agency Fund from surplus revenues generated by the energy cost savings.

The following two tables are presented to enable an estimation of the water fund costs for varies interest rates and time periods for complete payback, with interest.

To determine the **monthly** payments associated with an inter-agency loan, determine the interest rate and the loan period in months. Then find the factor in the table below for the interest rate and time period. Then multiply the amount of the loan by the identified factor.

	12 Months	24 Months	36 Months	48 Months	60 Months	72 Months	84 Months
1 %	0.08379	0.04210	0.02821	0.02126	0.01709	0.01432	0.01233
2 %	0.08424	0.04254	0.02864	0.02170	0.01753	0.01475	0.01277
3 %	0.08469	0.04298	0.02908	0.02213	0.01797	0.01519	0.01321
4 %	0.08515	0.04342	0.02952	0.02258	0.01842	0.01565	0.01367
5 %	0.08561	0.04387	0.02997	0.02303	0.01887	0.01610	0.01413

To determine the **yearly** payments associated with an inter-agency loan, determine the interest rate and the loan period in years. Then find the factor in the table below for the interest rate and time period. Then multiply the amount of the loan by the identified factor.

	1 Year	2 Years	3 Years	4 Years	5 Years	6 Years	7 Years
1 %	1.0100	0.5075	0.3400	0.2563	0.2060	0.1725	0.1486
2 %	1.0200	0.5150	0.3468	0.2626	0.2122	0.1785	0.1545
3 %	1.0300	0.5226	0.3535	0.2690	0.2184	0.1846	0.1605
4 %	1.0400	0.5302	0.3603	0.2755	0.2246	0.1908	0.1666
5 %	1.0500	0.5378	0.3672	0.2820	0.2310	0.1970	0.1728

F. Bank Financing Banking institutions provide financial assistance to public water systems to design and construct capital improvements to drinking water system infrastructure. This section provides an overview of the financing tools available and an explanation of the process.

Banks lend money to public water systems and like other funding partners evidence that loan with one of two instruments: 1) municipal bond certificates, or 2) lease purchase agreements. The bank’s benefit for lending the money is received from the interest charged on the loan. Interest paid by publically owned water systems is exempt from federal income tax requirements, allowing banks to charge a lower interest rate than would otherwise be charged.

Because banks lend money to make money, interest rates are determined by market conditions present at the time the financing takes place. Interest rates are a function of a bank’s cost of funds, the credit profile of the borrower, and the credit structure of the financing instrument used.

To determine the best course of action, the public entity will generally contact their public finance banker. Although the process varies by institution, in general obtaining bank financing is fairly simple and involves the following steps.

- Provide financial information regarding the governmental entity
- Provide details regarding the project
- Determine the timing of the project and when funds are needed
- Determine the financing tool that works best
- Finalize credit and pricing determination
- Execute the necessary steps to consummate the transaction and close the loan

A decision to provide bank financing can be obtained within a week or two in most cases. Executing the necessary steps to finalize a transaction depends on which instrument is used, but ranges from one to three months in most cases and can take much longer in some cases. These cases are rare.

Governmental entities in Utah are political subdivisions of the State of Utah, with laws dictating the process by which funding occurs. If these laws are not followed, the financing would be considered illegal, and therefore not enforceable for repayment.

Municipal Bonds

The key legal steps required to sell municipal bonds generally follow the pattern below and can be taken simultaneously with the financing steps outlined above.

- Initial resolution of the governing body starting the process
- Public hearing
- Authorizing resolution of the governing body
- Closing/funding

It is possible to combine the resolutions approved by the governing body to expedite the process.

Types of Municipal Bonds

Municipal bond is a generic label describing a wide variety of tax exempt obligations. Governmental entities may issue different types of municipal bonds depending on the revenue sources that they receive and that can legally be pledged. The decision regarding the correct type of municipal bonds to sell can usually be determined by examining what will be pledged, the nature of the project, and the expected source of repayment.

General Obligation (G.O.) Bonds: G.O. bonds pledge the ad valorem property taxes of a governmental entity and usually use this property tax revenue stream to repay the bonds. These bonds can be used to finance water system projects or energy conservation projects and are typically viewed as being low risk and, therefore, result in lower interest

rates. These bonds must be approved by over 50% of the voters in a special bond election held in November. There is a limit to the amount of G.O. bonds that can be issued based upon market value, population, and the type of governmental entity.

Revenue Bonds (Enterprise Fund): Revenue bonds pledge water, sewer, electric, or other enterprise funds and usually use these revenues to repay the bonds. They can only be issued after authorization from the governing body. Legal covenants typically require that revenues after operational expenses are paid equal at least 125% of the required bond payment. A governmental entity will have to increase its user fees to maintain this 125% coverage ratio.

Sales, Franchise, and Excise Tax Revenue Bonds: Local governments can pledge sales, franchise, or other excise taxes for bonds sold to finance water or energy conservation projects, and they can use these same funds or other funds to repay the bonds. Sales, franchise, and excise tax bonds have been a popular financing tool because they can be used to finance nearly any type of capital improvement; they do not require voter authorization—only authorization from the governing body; and they generally receive favorable credit reviews which lower the interest rates.

Lease Revenue Bonds: Lease revenue bonds can be issued by a governmental entity and its Local Building Authority (LBA, formerly known as an MBA or Municipal Building Authority). An LBA is created for the express purpose financing, acquiring, building, owning, selling and leasing real property and equipment. The LBA becomes the owner of the facility being financed and leases it to a governmental entity on an annual basis. The bonds are secured by the lease payments and by a first lien on the financed improvements. Because lease revenue bonds are subject to annual appropriation or annual lease payments, they do not require voter authorization, but are considered more risky and bear higher interest rates.

This tool could be used to finance equipment meant to conserve energy, but might be limited by other bonds outstanding that prohibit the use of system assets as security.

Tax Increment Bonds: Some governmental entities may create a Community Development Area (CDA), Economic Development Area (EDA), or an Urban Renewal Area (RDA), to facilitate a water project that benefits only a specific geography, not the entire jurisdiction, and uses tax revenue generated within this area for repayment of the obligation. These areas are called increment areas. The tax revenues generated are derived from the increase in the taxable value in a project area and would generally only exist in areas that did not have water access previously. The incremental increase in taxes generated from the higher taxable value that results from new water improvements acts as the collateral, or security, for these bonds and usually acts as the source of repayment as well. These types of bonds are relatively risky because the increase in tax

increment is often based on projected increases of development and valuation; hence, the full tax increment may not always be realized. Bond covenants usually require that debt-service coverage be at least 1.25 times to 2.00 times, which will dictate the amount of tax increment bonds that can be issued.

Special Assessment Bonds: Similarly, governmental entities can create special assessment areas within their boundaries to finance water improvements or energy efficiency projects that will have a benefit to a specific group of properties; the owners of which will be required to pay special assessments that are used to repay the bonds. Governments create assessment areas by adopting an ordinance (as long as those property owners responsible for more than 50 percent of assessment do not oppose the ordinance). Once the assessment area is created and an assessment ordinance is approved, bonds can be sold. Special assessments on real property acts as security for these bonds and the repayment source. In the event of default, the properties are subject to foreclosure. Land values should exceed the bond amount by at least three times, and usually more.

Bond Type	Security/Collateral	Payment Source
General Obligation	Ad valorem property tax	Property taxes or other legally available revenue
Enterprise Revenue	Water, sewer, electric or other enterprise revenue	Enterprise revenue
Excise Tax Revenue	Sales or other excise taxes	Excise taxes or other legally available revenue
Lease Revenue	Annual lease payments and financed improvements	Any legally available funds
Tax Increment	Incremental tax revenue from growth in CDA, EDA, or URA	Incremental tax revenue
Special Assessment	Land within an assessment area	Special assessment revenue

Lease Purchase Agreements

Lease purchase agreements are very similar to Lease Revenue Bonds described above, however a bank takes the place of the Local Building Authority and accepts lease payments from a governmental entity. Unlike a LBA, the bank does not own the financed improvements, instead they take a lien position on whatever is financed enabling them to foreclose, repossess or otherwise confiscate the improvements in the event of default. Because the financed improvements are used as collateral, this financing tool is not useful for improvements buried in the ground or difficult to move. Additionally, as mentioned previously, if water or energy efficiency improvements are integral to a system and other bonds are outstanding, it would generally be prohibited to take new improvements as collateral making this tool ineffective.

This tool works well for vehicles, solar panels, detachable equipment, and in some cases land or buildings that would not interrupt the water system process were they taken in a foreclosure.

Appendix

The Appendix lists helpful web sites that relate to energy efficiency and/or funding opportunities.

A. Case Histories of Water Systems taking advantage of energy cost savings:

- Mountain Regional Water Special Service District:
<http://www.deq.utah.gov/Topics/FactSheets/docs/handouts/2014/09Sep/MountainRegCS.pdf>
- Logan City:
<http://www.deq.utah.gov/Topics/FactSheets/docs/handouts/2014/09Sep/LoganCityCS.pdf>
- Riverton City:
<http://www.deq.utah.gov/Topics/FactSheets/docs/handouts/2014/09Sep/RivertonCS.pdf>

B. Drinking Water Board's financing program:

- The following web site accesses the application form for the Drinking Water Board's finance program:
http://www.deq.utah.gov/forms/water/dw/docs/2014/03Mar/Utah_SRF_Application.zip
- The following web site provides the scheduled for Board meetings:
http://www.deq.utah.gov/forms/water/dw/2014/03Mar/pdf/SRF_schedule.pdf
The following web site lists other State agencies involved in funding drinking water projects:
http://www.deq.utah.gov/FeesGrants/funds/drinkingwater/state_srf.htm

C. Utah Office of Energy Development's U-Save Program:

- Here is the link for more information on the U-Save program:
<http://energy.utah.gov/funding-incentives/energy-financing/>
- Here is the link to the U-Save Program Guidebook:
http://energy.utah.gov/download/u-save_documents_category_/U-Save%20Documents/U-Save%20Program%20Guidebook.pdf

D. Energy Service Companies:

- The following web site accesses the text of the State's "Facility energy efficiency Act":
<http://le.utah.gov/UtahCode/section.jsp?code=11-44>
- The following web site provides a list of State Pre-Qualified Energy Performance Contracting Service providers. Companies appearing on this list are pre-qualified to do work for the State of Utah by the Division of Facilities Construction Management:
<http://www.deq.utah.gov/Topics/General/energyefficiency/docs/2014/08Aug/PQ601.pdf>

E. Rocky Mountain Power's wattsmart program:

- For access to Rocky Mountain Power’s website dealing with their wattsmart program, including information about the program and application forms:
<http://www.rockymountainpower.net/utinentives>, [wattsmart.com](http://www.wattsmart.com) and
<http://www.rockymountainpower.net/utsave>

F. Web sites that give guidance on performing Energy Audits:

- South Dakota’s “Handbook on Energy Audits of Water Systems”: The following web site links to a document prepared by HDR Engineering Inc. for the State of South Dakota in fulfillment of a contract:
<http://denr.sd.gov/documents/11energyaudits.pdf>
- USEPA - Ensuring A Sustainable Future - Energy Management at Water Utilities:
http://www.epa.gov/owm/waterinfrastructure/pdfs/guidebook_si_energymanagement.pdf
- WRF - Energy Efficiency Best Practices for DW Utilities:
<http://www.waterrf.org/PublicReportLibrary/4223.pdf>
- Municipal Energy Efficiency and GHG Emissions Reduction - Financing Energy Efficiency Retrofits:
http://www2.epa.gov/sites/production/files/2014-04/documents/efab_report_municipal_energy_efficiency_ghg_emissions_reduction.pdf

G. Additional helpful web sites:

- The Lexington-Fayette Urban County Government oversees *Live Green Lexington*, a program that joins environmental policy, water quality, and waste management agencies to provide a set of environmental and energy programs aimed at consumers, businesses, and the public sector. <http://www.lexingtonky.gov/index.aspx?page=2323>
- States and local governments can amend existing regulations for public water and wastewater systems to include energy considerations in equipment procurement and improvements. Following the release of the *Water and Wastewater Energy Best Practice Guidebook*, (http://dnr.wi.gov/aid/documents/eif/focusonenergy_waterandwastewater_guidebook.pdf) the Wisconsin Department of Natural Resources encouraged energy considerations to be included in the required project cost-effectiveness calculations. Water and wastewater utilities can also incorporate energy efficiency into existing environmental goals or initiatives.
- Raising awareness within local governments and water and wastewater utilities on the benefits of energy improvements requires a clear demonstration of where waste exists in facilities, which can be accomplished for a low cost through a professional energy audit. Use EPA Portfolio Manager, or a similar tool, to gather and track energy data. NYSERDA’s Web page and the Best Practices Handbook listed below also contain excellent resources on benchmarking and payback analysis.

<http://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager>

<http://www.nysderda.ny.gov/Energy-Efficiency-and-Renewable-Programs/Commercial-and-Industrial/Sectors/Municipal-Water-and-Wastewater.aspx>

- AWWA's Water Loss Tool, an assessment tool to help water utilities evaluate, find and fix water leaks. <http://www.awwa.org/resources-tools/water-knowledge/water-loss-control.aspx>
- Improving Energy Management at Water and Wastewater Utilities in Massachusetts <http://www.mass.gov/eea/docs/dep/water/priorities/ener11.pdf>
- How to Boost Energy Efficiency in Municipal Facilities/Operations (New York State) <http://www.dec.ny.gov/energy/64322.html>
- Energy Use at Wisconsin's Drinking Water Facilities <http://www.ecw.org/sites/default/files/222-1.pdf>
- Energy Efficiency in Water and Wastewater Facilities <http://www.pwb.wa.gov/Documents/EPA-wastewater-guide.pdf>
- Financial and Technical Assistance for Green Projects (Maricopa Association of Governments, Arizona) https://www.azmag.gov/waterWorkshop/WaterWorkshop_Sess-2_PP-1.pdf
- Efficiency Vermont <https://www.encyvermont.com/For-My-Business/Solutions-For/Water-Wastewater-Facilities>
- An article entitled: "Evaluating the energy consumed for water use in the United States" authored by: Kelly T Sanders and Michael E Webber of the Department of Mechanical Engineering, The University of Texas at Austin http://iopscience.iop.org/1748-9326/7/3/034034/pdf/1748-9326_7_3_034034.pdf